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PATENT & TRADEMARK OFFICE

PATENT
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IN THE U.S. PATENT AND TRADEMARK OFFICE

In re Application of:

Applicant: Masayuki Takahashi et al.

Serial No.: 09/821,605 Art Unit: 2873

Filed: March 29, 2001 Examiner: Alicia M. Harrington

For: Charge Amount Detection Circuit and Two-Dimensional Image Sensor Using the Same

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CERTIFICATE OF MAILING UNDER 37 C.F.R. 1.8

I hereby certify that the following Amendment is being deposited with the United States Postal Service in an envelope by first class mail, postage prepaid on February 9, 2004, addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Laurie J. Brown

Laurie J. Brown

Date: February 9, 2004

RESPONSE

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This is in response to the Office Action mailed on September 8, 2003 (but incomplete until a missing page was faxed to applicants on November 14, 2003). A Request filed on November 21, 2003 to reset the period for response as beginning on November 14, 2003 is pending.

Claims 5-7 were previously indicated as defining allowable subject matter. That indication was withdrawn in view of a new reference to Fowler, U.S. Patent No. 6,459,078.

The present invention relates to a circuit and an image sensor using the circuit to detect an accumulated electrical charge. The circuit and sensor are particularly adapted for use in an X-ray diagnosis apparatus. Incident X-rays produce charged holes and electrons in a photoelectric conversion layer. The charge, which corresponds to the intensity of the X-rays incident on the detector associated with a pixel, is detected by the circuit.

The charge is collected periodically on a capacitor 17 associated with each pixel. Before sampling, a reset switch discharges the capacitor 17 to ground at a reference voltage. However, in practice, this discharge is not perfect, creating an offset voltage. In part, this offset is due to thermal noise from an amplifier that reads the accumulated charge. The noise power varies in proportion to the square root of the frequency band of the circuit. A low pass filter ("LPF"), e.g. an RC circuit, follows a charge sensitive amplifier to eliminate high frequencies and thereby control offset voltage being applied to a voltage amplifier.

Using both an LPF and a voltage amplifier in a detector circuit has another practical problem -- there is limited space for a LPF and amplifier for each data line 12. Space constraints therefore inhibit the use of an LPF in combination with each amplifier.

The claimed invention solves this space constraint problem.

Applicants respectfully traverse the rejection of all pending claims, Nos. 1, 2, 4, 6-9, and 11, under 35 USC 103(a) as unpatentable over U.S. Patent No. 5,332,893 to Potts in view of the new reference, Fowler. Potts is cited as showing a readout circuit with a charge sensitive amplifier, a low pass filter, and a voltage amplifier following the low pass filter. The Examiner argues that Potts does not disclose, however, a low pass filter and voltage amplifier that share a common element, as specified by applicants' claim 1.

The Examiner now cites the Fowler reference as showing this feature, shared "parallel capacitors and switches (col. 4, lines 44-54)."

The Fowler reference, however, does not include any teaching or suggestion at col. 4, lines 44-54, or elsewhere, that its "parallel capacitors" are shared by a low pass filter and an amplifier and switches.

While Fowler teaches a network of capacitors forming a variable capacitance feedback loop for op amp 43 (the voltage amplifier), these capacitors do not function as a component of a low pass filter, particularly an RC low pass filter as shown in Figs. 9-12 of the present application, and expressly defined in at least claim 4.

Further, while Fowler teaches the use of a capacitive feedback network as shown in Figs. 2 and 3, there is no disclosure of any low pass filter in these embodiments. To control offset noise, Fowler teaches different solutions, namely the use of a single, large op amp 133, as shown in Fig. 4, with "internal offset correction" (col. 5, lines 33-34) that operates on all detection circuits in the image sensor to force "all of the outputs of the op amp to be the same after the reset process is completed". This solution does not provide a LPF at each voltage amplifier. Nor is there any common element shared by a LPF and a following main voltage amplifier.

The Fowler patent does teach a low pass filter, but it is the capacitive network of elements 116 and 117 in Fig. 4 described at col. 5, lines 56-64 as acting to control offset noise generating by switch 118. This low pass filter has no element shared with the feedback network 112 (Fig. 4). Nor does this capacitive low pass filter follow a charge sensitive amplifier, as required by all of the pending claims.

Therefore, in summary, though the Fowler "low pass filter" is described in Figure 4 (capacitors 116 and 117; col. 5, lines 58-60) and claim 5, this low pass filter does not share its parallel capacitors and switch with an amplifier. Further, col. 4, lines 44-54, merely describes that "the capacitor network" is not limited to that made up of capacitors C1, C2, C3, and reset switches R1 and R2 of Figures 2 and 3, but may be varied in different ways; that is, the structures shown in Figures 2 and 3 may additionally include a capacitor or a switch, or may otherwise include other types of capacitor networks.

In response to the request for corrected formal drawings, applicants are filing herewith a letter to the Chief draftsman, together with 13 sheets for formal drawings that add the legend "PRIOR ART" to Figs. 1-9 and 13.

In view of the foregoing amendments and remarks, applicants respectfully urge that this application is clearly in condition for allowance.

Respectfully submitted,

Date: Feb. 9, 2004

By: _____

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The Commissioner is hereby authorized to charge any other fees under 37 C.F.R. 01.16 and 01.17 that may be required, or credit any overpayment, to our Deposit Account No. **04-1105.**

Respectfully submitted,

Date: February 9, 2004

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